Mem. Qd Mus. **18**(1): 119–123, pl. 21. [1977]

PENAROSA NETENTA, A NEW MIDDLE CAMBRIAN TRILOBITE FROM NORTHWESTERN QUEENSLAND

PETER A. JELL
Department of Geology, University of Queensland

ABSTRACT

A new species, *P. netenta*, is described and assigned to the nepeid genus *Penarosa* Öpik, 1970. The pygidium of *Penarosa* is correctly identified from this new species and, as the same pygidial type is known to occur in *Nepea*, it is taken to be typical of the family.

The only previous knowledge of the Nepeidae comprises the original description of *Nepea narinosa* Whitehouse, 1939, with a considerable discussion of its possible relationships (Whitehouse 1939, pp. 210–11); a reinterpretation of *N. narinosa* with clarification of all cephalic structures (Öpik 1963); description of two Upper Cambrian genera (Öpik 1967); and a monograph of Middle Cambrian species in 4 genera (Öpik 1970). This paper proposes a new specific name, provides a detailed description in modern terms of every aspect of the morphology of a nepeid species, and correctly identifies its pygidium pointing out Öpik's (1970) probable error in assignment of a pygidium to *Penarosa retifera* Öpik, 1970.

The material is deposited and catalogued (QM) in the Queensland Museum, Brisbane.

I am thankful to Dr J. B. Jago, South Australian Institute of Technology, Adelaide, for providing me with a latex cast of an uncatalogued, undescribed species of *Nepea* from Tasmania.

Family NEPEIDAE Whitehouse, 1939

Genus **Penarosa** Öpik, 1970

Penarosa Öpik, 1970, p. 24. (*Type species: P. retifera* Öpik, 1970, p. 25, figs. 9–10, pl. 8, figs. 1, 2; pl. 9, figs. 1, 2, 4; pl. 17, figs. 7–9 from the Age Creek Formation and Current Bush Limestone, northwestern Queensland and Northern Territory, *Euagnostus opimus* Zone, late Middle Cambrian; by original designation.)

Trinepea Palmer and Gatehouse, 1972, p. 25. (*Type species: T. trinodus* Palmer and Gatehouse, 1972, p. 25, pl. 4, figs. 1, 2 from the Nelson Limestone in the Neptune Range, Antarctica, *Amphoton oatesi* faunule, late Middle Cambrian; by original designation.)

DIAGNOSIS: Öpik's (1970, p. 24) diagnosis of the genus stands.

REMARKS: When Palmer and Gatehouse (1972) described *Trinepea*, they did not refer to Öpik's paper in which *Penarosa* was described. The size of the three bosses on the brim, the unpaired ocular ridges and the short (sag.) anterior border furrow are the only characters quoted as distinguishing *Trinepea*. In fact the lateral bosses on the brim are of similar size to those of several species of *Penarosa* (cf. Öpik 1970, pl. 9, fig. 5a; pl. 12, fig. 2b; pl. 13, fig. 1b); in several specimens figured by Öpik the ocular ridges are not clearly bifurcate (1970, pl. 9, fig. 1; pl. 12, fig. 2a) and in others the bifurcation only appears distally, a position where Palmer and Gatehouse's single figured specimen is damaged; and the short border furrow is only of specific value. *Trinepea* is thus clearly synonymous with *Penarosa*.

Penarosa netenta sp. nov.

Figure 1; Plate 21, figs. 1–8

Etymology: An anagram from my wife's name—Annette.

MATERIAL EXAMINED

HOLOTYPE: QMF7059, a cranidium from locality QML152.

PARATYPES: QMF7060–70, a cranidium, two free cheeks, an incomplete thorax and a thorax plus pygidium from locality QML152; and four cranidia and two free cheeks from locality QML136.

Queensland Museum locality L152 is 1·7 km south of Chummy Bore which is 6 km west of Thorntonia Homestead on the road to Camooweal at 19°31·5′S., 138°52′E. and QML136 is at Chummy Bore. The material occurs in weathered red, white or yellow siliceous shales of the Chummy Bore Formation (De Keyser and

Cook 1972) exposed in the low ridges just south of Chummy Bore as far as QML152. The associated agnostoid trilobites indicate an age within the Zone of *Euagnostus opimus*.

DIAGNOSIS: Member of *Penarosa* with upturned, slightly concave anterior border and border furrow; poorly vaulted cranidium; reticulate caeca of the respiratory prosopon (Jell, in press) on the brim but not in the border furrow; no transverse ridge on the brim; preglabellar boss as wide as the glabellar anterior and reaching the anterior border furrow in most specimens; 3 pairs of lateral glabellar furrows; ornament of coarse tubercles and finer interspersed granules; large distally expanded posterolateral limbs; more than 25 thoracic segments; an extremely small, simple, almost flat, transverse pygidium with an indistinct slightly elevated axis.

DESCRIPTION: Semicircular cephalon 0·5–0·6 times as long as wide. Glabella moderately convex, but remainder of cephalon relatively flat except for the posterior limbs. Comparatively short glabella (0·75 of preglabellar length) very slightly tapering anteriorly, with a squared anterior made more conspicuous by prominent, square, to slightly expanded, anterolateral corners. Occipital ring longest and relatively flat sagittally with a short almost vertical posteromedial spine; its posterior margin straight (tr.) over axial two-thirds but slightly anteriorly curved distally to the axial furrow. Occipital furrow well impressed laterally but shallow over the axial two-thirds, running posteriorly up from the axial furrow for slightly less than 0·25 of glabellar width, then anteriorly to meet the sagittal line at 70° to 80°. Other glabellar furrows discontinous axially. Furrow 1p best impressed, directed posteriorly at 45° to axial furrow and, from internal moulds, apparently forked adaxially. Furrow 2p parallel to furrow 1p, but furrow 3p directed anteriorly at 45° to axial furrow. Axial furrow very deep, uniform width, steeply walled against the glabella but with more gently inclined abaxial wall; accommodating small low bacculae adjacent to lobe 1p, and crossed anteriorly by the strong eye ridge.

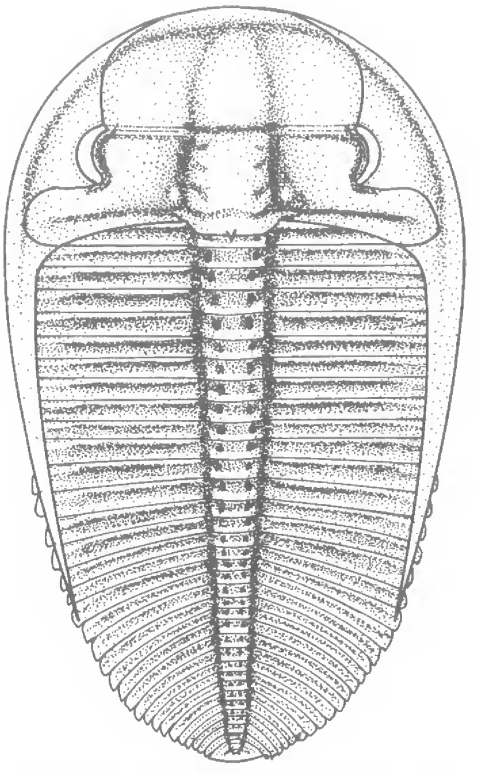

FIG. 1: Reconstruction of *Penarosa netenta* sp. nov. drawn from Plate 21, figs. 2, 3a and 6.

Preglabellar furrow moderately deep with rounded section (sag.), lateral fossulae just in front of eye ridges only slightly deeper than the rest of the furrow and with slightly steeper posterior wall than anterior one. Median boss dominant on the brim, equal in width (at its widest point) to glabellar anterior, tapering slightly forward, extending from preglabellar to border furrow, highest 0·3 of its length from the posterior from which point it descends very gently anteriorly and is bounded laterally by broad, very shallow, parallel furrows running from fossulae to border furrow. Lateral brim areas rising very gently from these furrows not inflated. Long (sag.) shallow border furrow with rounded bottom leading anteriorly to a short, flat to slightly concave, upturned, narrow (tr.) (by comparison with other species of the genus) anterior border. Anterior doublure long (i.e. half the border length) near the axis but soon tapering to almost nothing laterally. Shortly after crossing the margin the facial suture curved posteriorly to a sharp corner then as the rostral suture directly across the axis. Rostral plate unknown but, by fitting the free cheek with this anterior doublure, clearly defined.

Prominent eye ridges bifurcate near the axial furrow, then as two contiguous ridges in a straight to slightly anteriorly convex arc to the palpebral lobe anterior. Palpebral lobe not bifurcate (as the eye ridge), kidney shaped with the adaxial extremities in an exsagittal line and δ (at its widest point) behind its midlength; a raised ridge parallel and close to its abaxial margin; from this ridge sloping gently and flatly into a narrow, poorly impressed, palpebral furrow. Palpebral furrow turning abaxially behind the palpebral lobe. Fixed cheek width

1·3 times basal glabellar width. Facial suture opisthoparian, suture crossing border and border furrow very obliquely. ♀–♀ is narrow. β near the midlength (exsag.) of the brim and only just abaxial to ♀ giving the anterior branch an anterolaterally convex shape. ε opposite the midpoint of the glabella. Posterior margin straight (tr.) to the fulcrum then curved markedly posteroventrally to ω and just beyond before straightening slightly on the genal spine. Short posterior border convex adaxially but lengthening and flattening beyond the fulcrum. Posterior border furrow short and moderately deep adaxially, deepening adjacent to the fulcrum, then ceasing to be a discrete furrow; abaxially a very shallow broad depression as far as the facial suture. Posterior limb enlarged laterally, swinging posteriorly as a rather flat lobate structure. Posterior branch of the facial suture transverse from ε for a short distance then curved posteriorly and finally swinging around the ovate to round termination of the posterior limb to the posterior margin. Posterior border and occipital ring not connected, instead occipital ring dying out into the posterior border furrow and lobe 1p connected through the baccula to the posteroproximal corner of the fixed cheek.

Ornament on the exoskeleton varying from one area to another; absent on the smooth palpebral lobes and in the axial furrow, whereas on the fixed cheeks and central boss a single order of moderately large, relatively sparsely scattered tubercles present. On the remainder of the cranidial exoskeleton, a much denser ornament of moderately sized tubercles and interspersed granules an order of magnitude less than the tubercles evident. The brim exhibiting a respiratory prosopon of generally parallel sometimes anastomosing ridges running forward from the eye ridges and preglabellar furrow to the border furrow. The majority of the large brim tubercles appear to be on the caecal ridges.

Free cheek dominated by the genal spine but also with a trapezoidal subocular part and a posterior part extending back into the genal spine. Subocular part with strongly upturned though uniformly low eye socle, with gently abaxial slope anteriorly becoming much steeper posteriorly, with shallow narrow, moderately distinct border furrow, flat only slightly upturned border and typical cephalic brim prosopon. Large embayment in the free cheek, accommodating the posterior cranidial limb; extending to the border furrow. Small posterior part sloping steeply abaxially; crossed by a shallow border furrow fading out on the genal spine; with a sharp point adaxially on the posterior margin and drawn out posteriorly into a strong genal spine extending posteriorly at least to within 15 segments length of the pygidium and possibly further.

Doublure extending only to the border furrow in the subocular area; rounded section (tr.) leaving a large volume between it and the dorsal border; anteriorly very close to the dorsal surface marginally, well separated from the dorsal exoskeleton at the border furrow and returning to just beneath the brim for a short distance posteriorly; sutural ending adaxially as described above; inner margin curved adaxially across the base of the genal spine to the posterior margin where doublure virtually absent. Genal spine with complete doublure (i.e. hollow) and shallow ventral medial furrow fading out posteriorly. Doublure with a uniformly tuberculate ornament throughout.

Thorax of 25 or more segments but probably not more than 35. Anterior thoracic width slightly less than cranidial width as posterior limbs extend beyond pleural tips. Width constant to midlength (exsag.) but tapering strongly beyond this point. Genal spines curved in, to be touching pleural tips from mid to three quarter length. Segment shape varying through the thorax from directly transverse (between the fulcra) anteriorly to markedly anteriorly convex near the posterior (last 10–15 segments). Axial to pleural width ratio decreasing posteriorly from 0·56 for first 10 segments down to 0·4 in front of pygidium. Short half ring equal in length to the articulating lobe and maintaining its length almost to the axial furrow where it tapers sharply to nothing. Articulating furrow well impressed, shallowest at axial furrow then deepest and longest a third of the way to the sagittal line; with steep almost vertical anterior wall to the angular posterior margin of the half ring and more gently sloping posterior wall; with lateral pits representing apodemes (even more prominent on internal moulds extending almost to the level of the floor of the axial furrow and being slightly expanded adaxially as well as extending to the axial furrow). Articulating lobe expended just abaxial to the apodemal pits; bearing ornament of tubercles slightly finer than the cephalic ones. Pleural furrow dominating the pleura by occupying its entire length adjacent to the axial furrow and at least three quarters of the length as far as the fulcrum; beyond this point shallowing and shortening to finish near rounded pleural tips; anterior wall is almost vertical and posterior wall, although steep (to 60°) adaxially is more gently sloping. Extremely short (exsag.) pleural bands of variable but generally equal length, increasing gradually in length beyond the fulcrum, coalescing near the pleural tip and carrying a single prominent row of fine

tubercles. Wide (tr.), short (exsag.) poorly defined facet present anterolaterally. The prominently convex axis stands above the pleural areas that are deflexed ventrally in the fulcral line.

Pygidium extremely small, almost oval with curved anterior margin against the last thoracic segment and curved posterior margin rounding off the posterior of the exoskeleton. Axis occupying more than half width; reaching almost to the posterior margin; slightly raised above pleural areas; and with at least 2 very poorly impressed transaxial furrows. No axial furrow. Articulating half ring not preserved on this specimen. Pleural areas smooth.

Intraspecific variation is restricted to slight variability in size and shape of the palpebral lobe, size of the posterior limb, upturning of the anterior border, and ornament.

REMARKS: The material is preserved in a porous siliceous shale so that the 'furry' appearance of the latex casts is partly the result of the latex having penetrated the minute pores of the matrix. Several specimens have been crushed by compaction but the breakages are obvious. Uncrushed specimens definitely have a low cephalic convexity. On the specimen figured in Plate 21, fig. 6, there are grooves along the pleural tips with tuberculate ornament in the bottom. These are interpreted as the external moulds of genal spines, and the specimen is thought to be a damaged fragment of one originally fossilized with its entire dorsal exoskeleton in place.

Öpik (1970, p. 28, text-fig. 11, pl. 9, fig. 3) described a pygidium with four axial rings, longer than half its width, and with a row of pustules on each pleural band, as belonging to *Penarosa retifera*. This pygidium, estimated by Öpik to be 0·2 to 0·25 of cephalic length, would be relatively large for the thoracic segments of *P. retifera*. It is not associated with any thorax or cephalon. The pygidium described for *P. netenta* below (Plate 21, fig. 6) is very much smaller, being less than 0·1 of cephalic length and only slightly wider than long. It is associated with a thorax the anterior segments of which exactly match those associated with the cephala of *P. netenta*. Further, the associated thorax bears laterally a groove with rounded pitted floor that exactly matches the position, shape and ornament of the genal spine of a penarosid. From these observations it can definitely be concluded that the pygidium belongs to a species of *Penarosa*, namely *netenta*, the associated cephalic specimens. Moreover, the pygidium of a poorly preserved but complete specimen of an undescribed nepeid species from the Christmas Hills, northwestern Tasmania, is almost identical with that described in *P. netenta* below. No such conclusion can be reached about Öpik's identification of the pygidium of the very closely related *P. retifera*. On the contrary there are good reasons for believing that his identification is not correct and that the pygidium he assigned to *P. retifera* does not belong to the Nepeidae at all. Thoraxes of *Nepea* and *P. netenta* show a progressive reduction of the pustules on successive segments, and that they are absent on the most posterior ones and on the pygidium. Öpik's specimen exhibits pustules very much larger than those on the associated cephala. Moreover, judging from the sizes of the known pygidia of *Nepea* and *P. netenta*, the total width of the pygidium is only about half the width of the occipital ring of the same individual, whereas the proposed pygidium of *P. retifera* would be at least equal to the occipital width of the same individual. Differences of this magnitude are unlikely in view of the conservative nature of the pygidium throughout a wide range of related genera. For example the related species *Alokistocare harrisi* Robison, 1971 and *Bolaspidella wellsvillensis* (Lochman and Denson, 1944) figured by Robison (1971, pl. 91) show remarkable pygidial similarity to *P. netenta* and *Nepea* sp. nov.

Öpik described and figured (1970, p. 39, pl. 16, fig. 2) the free cheek unit of *Penarosa petalifera* and concluded that no median suture or rostral plate existed. The ventral structure of *P. netenta* is somewhat different. The sutures described on the doublure (Pl. 21, fig. 7) along with the appearance of a sutural termination to the anterior of the free cheek (Pl. 21, fig. 5) indicate clearly the presence of connective sutures and a rostral plate, very much like that described for species of *Bolaspidella* (Robison 1964, pl. 88, fig. 19) and indeed structurally similar to most ptychoparioid rostral plates. The suggestion is made that Öpik's specimen, if prepared further may turn out to be a complete animal that has not moulted. If this is not the case then fusion of the sutures has occurred in this youngest species of the lineage.

Of Öpik's (1970, p. 45) three groups within *Penarosa* this new species belongs to the 'rimless' *retifera* and *vittata* group which also includes his sp. nov. PC, sp. nov. Pd and sp. nov. PE. *Penarosa vittata* is distinguished by the transverse ridge in the anterior border furrow, much wider fixed cheeks, smaller posterior limb, narrower median boss, better impressed glabellar furrows and more prominent venulose brim ornament. *Penarosa* sp. nov. PD and sp. nov. PE are not sufficiently preserved for comparison. *Penarosa retifera* is distinguished by its highly vaulted cephalon, its fourth lateral glabellar furrow, narrower median boss, more

tapering glabella, wider fixed cheeks, denser fixed cheek ornament, more anteriorly expanded posterior limb, and venulose ornament extending through the border furrow on to the border. *Penarosa* sp. nov. PC is probably conspecific with *P. netenta* but the figured specimens do not allow complete agreement to be reached. Öpik's text-fig. 14 appears to show a fourth lateral glabellar furrow, a narrow boss (damaged) and wide, convex, palpebral lobe.

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